3.G.6 e. (cont'd) not be appropriate for some types of batteries (such as gel-cells) which generate very little to no hydrogen gas. In such cases, the quantity of gas generated should be compared to the amount released by lead-acid batteries to determine whether the installation should is large, moderate, or small. The battery manufacturer, designer, or shipbuilder should provide this comparison to the USCG.

Sealed batteries, which release gas only when a relief valve opens following an over-voltage charge, may also be accepted. However, their installation must consider the over-charge condition, and allow released gas to be safely dissipated. The lining requirement of 46 CFR 111.15-5(g) allows the acceptance of plastic battery trays and liners certified by the manufacturer as resistant to the corrosive effects of the battery electrolyte. Battery chargers that meet UL 1564 (Industrial Chargers) plus the marine supplement to UL 1236 may be accepted as equivalent to those meeting UL 1236.

f. Emergency Power Batteries. Automotive-type batteries are not suitable for emergency power applications, as indicated in NEC Article 700-12. Automotive batteries are designed for frequent, short duration, high current loading; emergency power systems usually operate less frequently, for longer periods, at lower current levels. Automotive batteries also have a shorter life (3 - 5 years) than lead-acid storage batteries designed for use in emergency power systems (15 - 20 years). Storage batteries for emergency power service have either a threaded stud or a rectangular blade for connection of a bus link. They usually have external cell connectors. Automotive batteries have either side terminals that can accept a threaded bolt, or top round posts for an automotive battery cable.

7. Transformers (46 CFR 111.20).

a. Sectionalized And Redundant Transformers (46 CFR 111.10-9). Sectionalized buses increase the ability to provide ship's service power in the event of a casualty to part of the switchboard. On a single voltage level system (i.e., where generated voltage is the ship's service switchboard voltage), the devices used to connect the sections of the buses must be manually operable. In a dual level system, (i.e., in which the generators connect to a medium-voltage bus which in turn supplies the low-voltage ship's service switchboard) at least two transformers or transformer banks are required by 46 CFR 111.10-9. If the medium-voltage bus is required to be sectionalized and the total capacity of these transformers exceeds 3000 KW, the low-voltage ship's service switchboard must also be subdivided. On a dual level system, automatic control of the sectionalizing may be permitted when it is part of a load management system allowing for increased system flexibility.

b. Transformers - Protection (46 CFR 111.20-15). The overcurrent protection for each transformer is required by 46 CFR 111.20-15 to meet Article 450 of the NEC or IEC 60092-303. The transformer overcurrent protection specified in Section 450-3 is intended to protect the transformer alone; the primary and secondary conductors may not be adequately protected. Be careful to ensure that conductor protection is provided. Note that where the primary feeder to the transformer is provided with overcurrent protective devices that are set per section 450-3, it is not necessary to install an individual

3.G.7 b. (cont'd) overcurrent device at the transformer. The primary conductors must then be sized so that their ampacity is greater than or equal to the rating or setting of the primary overcurrent protective device(s); see 46 CFR 111.50-3(a), (b), and 111.50-5(a). Secondary conductors supplied by a transformer must be protected in accordance with their ampacity. The secondary conductors of a single voltage single-phase transformer which satisfies the requirements of 46 CFR 111.50-5(a)(4) do not require overcurrent protection at the supply (the transformer) to the secondary side conductors. Aluminum-wound transformers are acceptable. They should be fully encapsulated by the manufacturer and all connections should be made in accordance with the guidelines for aluminum current-carrying parts in section 3.G.8 of this guide. See the next section for full load current ratings for single-phase and three-phase transformers.

c. Miscellaneous Tables.

Current Rating, Rectangular Bus Bars on Edge, 50 C Rise, IEEE 45-1983, A27 Single Bars in Parallel, Copper		
SIZE (inches)	DC	AC, 60HZ
3/4 x 1/8	250	250
1 x 1/8	330	330
1-1/2 x 1/8	500	500
1-1/2 x 3/16	580	570
2 x 3/16	760	745
1 x 1/4	490	480
1-1/2 x 1/4	685	675
2 x 1/4	920	900
3 x 1/4	1380	1280
4 x 1/4	1730	1650
5 x 1/4	2125	2000
6 x 1/4	2475	2300
8 x 1/4	3175	2875

Minimum Switchboard Spacing (inches)			
	LIVE PARTS, OPP. POLARITY,		BETWEEN LIVE PARTS & GROUNDED
Voltage	Over Surface	Thru air	Dead metal
125V or less	3/4	1/2	1/2
126V - 250V	1 - 1/4	3/4	1/2
251V - 600V	2	1	1

From NEC Table 384-26

Neutral Grounding Conductors, AC Systems	
A.W.G. OF LARGEST GENERATOR CONDUCTOR OR EQUIVALENT FOR PARALLEL	A.W.G. OF GROUND CONDUCTOR
Up to #2	#8
#2 - #0	#6
#0 - 3/0	#4
3/0 - 350 MCM	#2
350 MCM - 600 MCM	#1
600 MCM - 1100 MCM	2/0
Greater than 1100 MCM	3/0

See 46 CFR 111.05-31(b).

3.G.7.c (cont'd)

Generator Continuous Full Load Ampere Ratings.													
3 - Phase 0.8 Power Factor													
		115%		115%		115%		115%		115%		115%	
KW	KVA	208V	FLA	230V	FLA	240V	FLA	460V	FLA	480V	FLA	600V	FLA
5.0	6.3	17.5	20	15.8	18	15.2	17	7.9	9	7.6	9	6.1	7
7.5	9.4	26.1	30	23.6	27	22.6	26	11.8	14	11.3	13	9.0	10
10.0	12.5	34.7	40	31.4	36	30.1	35	15.7	18	15.0	17	12.0	14
15.0	18.7	52.0	60	47.0	54	45.0	52	23.5	27	22.5	26	18.0	21
20.0	25	69.4	80	62.8	72	60.1	69	31.4	36	30.1	35	24.1	28
25.0	31.3	87.0	100	78.6	90	75.3	87	39.1	45	37.6	43	30.1	35
30.0	37.5	104.1	120	94.1	108	90.2	104	47.1	54	45.1	52	36.1	42
35.0	50.0	138.8	160	125.5	144	120.3	138	62.7	72	60.1	69	48.1	55
40.0	62.5	173.5	200	156.9	180	150.3	173	78.4	90	75.2	86	61.1	70
45.0	75.0	208.2	239	188.3	217	180.4	207	94.1	108	90.2	104	72.2	83
50.0	93.8	260.4	300	235.4	271	225.6	259	117.7	135	112.8	130	90.3	104
60.0	125.0	347.0	399	313.8	361	300.7	346	156.9	180	150.4	173	120.3	138
75.0	156.0	433.0	498	391.6	450	375.3	432	195.8	225	187.6	216	150.1	173
80.0	187.0	519.1	597	469.4	540	449.8	517	234.7	270	224.9	259	179.9	207
100.0	219.0	607.9	699	549.6	632	526.7	606	274.8	316	263.3	303	210.7	242
125.0	250.0	694.0	798	627.6	722	601.4	692	313.8	361	300.7	346	240.6	277
150.0	312.0	866.1	996	783.2	900	750.5	863	391.6	450	375.3	432	300.2	345
175.0	375.0	1040.1	1196	941.3	1082	902.1	1037	470.7	541	451.1	519	361.0	415

Notes: (1) Generator cables shall be capable of carrying at least 115 percent generator continuous F.L.A. (see 46 CFR 111.60-7).

(2) Generator circuit breaker long time overcurrent trip shall not exceed 115 percent generator continuous F.L.A. (see 46 CFR 111.12-11).

(3) KW = KVA * PF

(4) Amperes = $\frac{\text{KVA x 1000}}{\text{Volts x 1.732}}$

Transformer Full Load Currents.						
3-Phase Transformers Voltage (Line to Line)						
KVA Rating	208	240	480	800	2400	4180
3	8.3	7.2	3.6	2.9	0.72	0.415
6	16.6	14.4	7.2	5.8	1.44	0.83
9	25	21.6	10.8	8.7	2.16	1.25
15	41.6	36.0	18.0	14.4	3.6	2.1
30	83	72	36	29	7.2	4.15
45	125	108	54	43	10.8	5.25
75	208	180	90	72	18	10.4
100	278	241	120	96	24	13.9
150	416	360	180	144	36	20.8
225	625	542	271	217	54	31.2
300	830	720	360	290	72	41.5
500	1390	1200	600	480	120	69.4
750	2080	1800	900	720	180	104
1000	2775	2400	1200	960	240	139
1500	4150	3600	1800	1440	360	208
2000	5550	4800	2400	1930	480	277
2500	6950	6000	3000	2400	600	346
5000	13900	12000	8000	4800	1200	694
7500	20800	18000	9000	7200	1800	1040
10000	27750	24000	12000	9600	2400	1366